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THE CONTROL OF RADIATION HAZARDS IN THE UNITED STATES. REPORT TO THE SURGEON GENERAL

National Advisory Committee on Radiation

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REPORT TO THE SURGEON GENERAL

U. S. PUBLIC HEALTH SERVICE

ON

THE CONTROL OF RADIATION HAZARDS IN THE UNITED STATES

PREPARED BY

THE NATIONAL ADVISORY COMMITTEE ON RADIATION

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I. FOREWORD

The National Advisory Committee on Radiation was formed in 1958 by the Surgeon General of the U. S. Public Health Service, to provide him guidance in matters pertaining to the control of radiation hazards in the United States. Among the many assignments which have been given the Committee since its inception, one has been the task of evaluating the programs currently followed in this country to protect the health and well being of the public from the hazards of ionizing radiation. This report presents the conclusions reached by the Committee after its study of this important subject.

II. RADIATION HAZARD, A PROBLEM IN PUBLIC HEALTH

During the past several years, a number of scientific bodies, including the National Academy of Sciences of the United States[1] and the United Nations Scientific Committee on the Effects of Atomic Radiation[2], have reported extensively on the influence of ionizing radiation on biological systems. From these reports it is evident that serious health problems may be created by undue radiation exposure and that every practical means should be adopted to limit such exposure both to the individual and to the population at large.

The principal sources of ionizing radiation which have been created or developed by man include x-ray machines, nuclear reactors and their radioisotopic byproducts, high-energy particle accelerators, a number of concentrated forms of naturally occurring radioactive materials, and the fallout constituents of nuclear weapons. Among these sources, only nuclear reactors, their fuels, their radioisotopic byproducts, and their radioactive wastes have been placed under substantial regulation from the standpoint of their influence on health and safety. This is notwithstanding the fact that

calculations based on estimates of the x-ray film consumption of the country during this time period[3, 4]. The continued upward trend exhibited by the x-ray data suggests the likelihood that the current exposure of the population from x-ray apparatus may increase still further unless appropriate radiation control measures are systematically applied.

TABLE I. Estimated Annual Whole-Body Dose in Millirems Received Externally from Natural and X-ray Sources

YEAR	NATURAL SOURCES	X-RAY SOURCES
1925	100	15
1935	100	40
1945	100	75
1955	100	135

The radiation exposure received from atomic sources is also likely to increase with the passage of time. This is well demonstrated in table II, where the national growth in nuclear power capacity is predicted for the years 1965 through 1995. The table also includes estimated values of the accumulated volume of radioactive waste which may be expected to result from this nuclear power development[5].

TABLE II. Predicted Power Capacity and Accumulated Volume of Radioactive Waste Resulting from Development of the Nuclear Power Industry

Year	Power Capacity (megawatts)	High and Intermediate Level Waste Products (gallons)
1965	1.5×10^4	1.5×10^6
1975	8×10^4	2×10^7
1985	2×10^5	8×10^8
1995	5×10^5	2×10^9

Another measure of the growth to be anticipated in the field of atomic energy may be made from an examination of the actual growth which has taken place during the last few years in the use of radioisotopes in the United States. This is shown in Table III, where the quantity of radioisotopes shipped from the Oak Ridge National Laboratory from 1952 to 1958 and the number of medical users of radioisotopes in the United States in a similar period are tabulated[6, 7].

Table III. Curies of Radioisotopes Shipped by Oak Ridge National Laboratory and Number of Medical Users of Radioisotopes in the United States

YEAR	Curies	Number of Users
1952	12,000	445
1954	30,000	870
1956	100,000	1533
1958	230,000	1935

In addition to the rapid, anticipated growth in the use of devices and products which produce ionizing radiation, there is another factor which urgently points to the nation's need for a comprehensive program governing the public health aspects of this radiation. This is the increasing respect given by scientists to radiation exposure as demonstrated by the steady downward revision, made over the past thirty years, in the maximum permissible levels of ionizing radiation recommended by the National Committee on Radiation Protection and other authoritative groups (Table IV)[8, 9, 10, 11, 12].

Each downward revision increases the responsibility of those concerned with the problems of radiation protection.

Table IV. Recommended Annual Maximum Permissible Dose in Rems for Workers Occupationally Exposed to Ionizing Radiation

Period	Maximum Permissible Dose (Annual)
1931-1936	60
1936-1948	30
1948-1958	15
1958-present	5

III. THE ELEMENTS OF A RADIATION CONTROL PROGRAM

A comprehensive program for the control of radiation hazards includes many elements; two are particularly worthy of attention:

(a) the formulation of sound radiation protection standards and

(b) the enforcement of public health regulations based upon these standards.

In general, the process by which a regulating agency formulates the protection standards employed in its operation consists of (1) the collection of pertinent scientific data, developed through sound research, (2) the judicious evaluation of these data by individuals whose background and training qualify them to the task, and (3) the preparation of written standards, guided by this evaluation, after due consideration of any socio-economic problems which the standards may create. Frequently the group performing the data evaluation is an organization independent of the regulatory agency.

The enforcement of health regulations by a controlling agency involves the adoption of specific procedures designed to insure that the agency's standards are honored. In the field of radiation control, these procedures include, among others, the establishment of mechanisms for the registration of radiation sources, the approval of operators and of facilities and the periodic inspection of these facilities.

It may be worthwhile at this time to examine briefly the methods currently used in the United States in the formulation of standards of radiation protection. In regard to scientific data, considerable research in radiation biology, chemistry and physics is contributing to the store of scientific knowledge needed for standards development. This research is being supported by the Division of Biology and Medicine of the Atomic Energy Commission and the National Institutes of Health of the Public Health Service as well as many other governmental and non-governmental groups. Although the magnitude of this research is substantial, a review of current scientific data, which quantitatively relate radiation dose to biological effect, indicates that many gaps exist within these data and that such gaps pose great difficulty in the establishment of many radiation protection standards on a wholly satisfactory basis. Since standards of radiation protection are of fundamental importance to programs of radiation control, it appears to this Committee that even greater emphasis must be placed on radiation research in the future. This is particularly so of scientific studies which focus directly on the provision of data for standards development. Certainly, such research should be an important component of the radiation control program now in the process of development by the Public Health Service.

Much of the responsibility for the evaluation of radiation data and the subsequent preparation of recommendations which may be used as guides by regulatory agencies in the development of their operational protection standards, has been borne in the United States by the National Committee on Radiation Protection, a private quasi-official group of internationally known American and Canadian scientists who are modestly supported in their work by the Department of Commerce. The organization deserves great praise for the untiring effort it has given on behalf of the nation for many years.

From time to time, a number of individuals and groups have suggested that the NCRP should be made a component of some specific governmental agency. They believe that, under these circumstances, the Committee would gain stature and its recommendations would benefit from the more official status given them. The National Advisory Committee on Radiation, however, believes that there is much merit in the independent position which the NCRP enjoys. In such a climate, the actions of the NCRP have been singularly forthright and decisive and it is felt that it would be unfortunate if these characteristics were changed.

IV. STATE VS. FEDERAL REGULATION OF RADIATION PROTECTION

The enforcement of radiation protection regulations has been the subject of considerable controversy in recent years. There are some who believe that the dangers of ionizing radiation are so great and the control of radiation hazards so complex that regulatory responsibility in this field must lie at the federal level. Others have argued that regulatory functions are

best executed at the state or local level. The following discussion reviews the controversy in an effort to resolve this difficult problem.

The Federal Government, under authority granted by the Atomic Energy Act of 1954[13], occupies a dominant position in the field of atomic energy. Through its control of atomic fuels, production facilities, utilization facilities, facility operators, byproduct materials, classified data and patents, the Federal Government through its operating agency, the Atomic Energy Commission, exercises a profound influence over the development of atomic science in industry, medicine, and a large number of other areas within our social structure. In addition to its responsibility for the promotion and development of atomic energy, the Atomic Energy Commission has been given authority to regulate its operations and those of its contractors in such a manner that the safety of the population both individually and collectively may be maintained.

The real and potential problems imposed upon our social structure by developments in atomic energy are principally those associated with the control of the radiation, electromagnetic and particulate, created by nuclear processes. The extent of these problems goes far beyond the atomic energy production facilities. The widespread use of byproduct materials from nuclear reactors in a continuously increasing number of laboratories throughout this country poses a whole set of additional problems in radiation protection. Furthermore, the disposal of unwanted nuclear wastes of the magnitude which may be contemplated when the atomic industry is fully developed presents problems in terms of world population exposure which

are sufficiently far from a solution at the present time that many years may be expected to elapse before they fall under control.

The dual role of a single governmental agency in the promotion and development of atomic energy on the one hand and its regulation of radiation safety on the other is an interesting one. Generally, such an arrangement is unwise and may be expected to create difficulty. For example, during its lifetime, the Atomic Energy Commission on a number of occasions has been criticized for seemingly subordinating radiation safety in the interest of economy when several of its nuclear reactor installations have been planned; also, a number of individuals and groups have expressed concern over the establishment of large reactors not far from densely populated areas. Whether these criticisms have been justified or not, it is noteworthy that the dual responsibility of the Commission has been the cause of not inconsiderable misunderstanding and this may be expected to increase in the future, particularly as more and more participation in nuclear science by private groups takes place.

The question may be reasonably asked why the dual responsibilities of promotion and regulation of radiation safety were placed in a single governmental agency when the shortcomings of such a practice are so apparent. The reasons for this may be found in the history of the atomic energy development. Nuclear science began to exert a dominant role in our social structure only at the time of World War II. During this period, major effort was directed toward the development and production of nuclear weapons, an effort wholly concerned with the military establishment of our government.

Progress toward the production of practical atomic weapons was attended by the need for the rapid development of competence in the field of radiation safety and, because of secrecy, it was impractical to develop such competence in a regulatory body wholly independent of the production group. Hence, the functions of weapons development and protection regulation were administered by a single agency, the Manhattan Engineering District.

After the completion of World War II, the Atomic Energy Commission was established by the Atomic Energy Act of 1946[14]. The function of the Commission, initially, was almost wholly governmental and only relatively minor private participation in the field of nuclear science was contemplated. In view of this, the wartime responsibilities of the Manhattan Engineering District were transferred to the new Atomic Energy Commission and the dual responsibilities of promotion and regulation were carried essentially unchanged to the new organization.

When the Atomic Energy Act of 1954 was written, regulation of radiation protection was continued as a prime responsibility of the Commission in the atomic energy field. However, such regulation became immediately more complex and difficult because private enterprise was encouraged to take a vigorous role in the development of nuclear science.

The propriety of the Atomic Energy Commission to perform a regulatory function in radiation safety was soon questioned by a number of groups which believed that such responsibility is a function of state and local agencies, rather than that of the Federal Government[15, 16]. This, incidentally, is notwithstanding ample legal precedent where federal

regulatory power has pre-empted state responsibility in instances where national interest was at stake[16].

It is not difficult to suggest examples where national interest might not be well served if regulation of radiation protection in the field of atomic energy were delegated entirely to state and local agencies. First, circumstances frequently occur where radiation hazards do not respect state and local boundaries and serious danger may be expected to develop if wider control is not provided. Furthermore, the existence of a variety of local and state radiation protection codes each with differing standards might impede the development of atomic machinery and techniques to such an extent that national interest might well be severely jeopardized. Finally, a high level of competence has been achieved by scientists associated directly and indirectly with the Atomic Energy Commission and their ability to provide the technical knowledge necessary for the execution of sound programs in radiation protection is substantial. Indeed, the performance of those so concerned constitutes a record of which the AEC may be justly proud. At the state and local levels, on the other hand, such competence is only now beginning to develop.

In spite of the foregoing, the arguments for state versus federal regulation of radiation safety are not entirely on the federal side. Although competence in radiation safety has lagged until recently in many state and local health departments and in other agencies concerned with safety problems, intensive efforts are now being made to correct this shortcoming. Evidence of this may be found in a recent survey of sixteen states, conducted by the Public Health Service, which reveals that 76 radiation health specialists

and technical assistants are currently at work in the field of radiation control in the health departments of these states. Also, history gives strong support to the concept that where regulatory controls are needed for the safety of a community, these controls may be best exercised where the authority responsible for control is not far removed from the group or groups being protected. This concept is likely to prove equally valid in the field of radiation protection for many radioactive materials used in medicine and industry, even though initially regulated, eventually become a part of environmental contamination and of necessity must be evaluated at the point of human exposure as a part of a normal health assessment program. Finally, many state and local governments have demonstrated over long periods of time that they are quite capable of operating effective control programs in important areas of human activity; for example, the record of public health authorities is difficult to surpass in the field of sanitation.

After careful consideration of the problem of states-vs-federal control of radiation safety, the Committee believes that many of the regulatory enforcement functions of a radiation control program may be discharged effectively by state and local governmental agencies. Also, the Committee believes it unwise to continue the assignment of primary authority over the public health aspects of atomic energy in the same agency that has a prime interest in the promotional aspects of the field. By this, the Committee in no way wishes to imply criticism of the Atomic Energy Commission. It merely wishes to express a principle which it believes to be fundamentally sound. Furthermore, the Committee does not wish to imply

that the AEc should not continue to pursue intensive radiation safety programs for the control of hazards in its own installations and in those of its contractors and licensees. Indeed, on the contrary, the Commission has an obligation to do so. In this respect, the position of the Commission is similar to that of many of our nation's industries which have responsibilities for the provision of a broad range of safety practices beyond those of the regulatory agencies having primary authority over the industries. However, to return to the question of where the ultimate authority should fall for decisions of policy in matters involving the protection of the public's health against ionizing radiation, the Committee believes this authority should be placed in an independent agency and preferably in one with a special interest in public health; i.e., the U. S. Public Health Service.

V. RADIATION SAFETY PERSONNEL

The increasing urgency for a comprehensive program of radiation protection in the United States, cited in Section II of this report, requires that there be available an ever increasing number of individuals, well trained in radiation control methods, with whom federal, regional, state and local agencies may conduct their regulatory functions. The types of individuals who are needed fall into two general categories:

(a) radiation health specialist* and

(b) radiological technicians.

* These individuals are not to be confused with health physicists, persons employed principally in industry to plan and supervise the specific radiation protection operations of the plants in which they are working.

By the term, radiation health specialist, is meant a person trained to the level of a master's or doctor's degree in the problems of radiation protection and capable of assuming a high order of responsibility in a radiation control program. This training should include advanced work in physics and the allied basic sciences, pertinent biological subjects including genetics, radiobiology, and biomathematics and practical experience in handling laboratory and field problems. By the term, radiological technician, is meant an individual trained to operate radiation measuring equipment and to conduct technical work under the supervision of a radiation health specialist.

At this time, the need for radiation health specialists appears to be most critical. Until such personnel are available in substantial numbers, programs in radiation control cannot become fully effective at any government level. Inadequately trained individuals will not be able to make the numerous judgments nor perform the complex technical operations which will be required of them.

From studies made by this Committee, it appears that the following constitute the personnel needs of the United States in the field of radiation control through the year 1970:

(a) radiation health specialists - 1,200

(b) radiological technicians - 4,000

These estimates are based upon the belief that approximately three to four technicians will be required for each health specialist in a nominal control program and that approximately one radiation health specialist will be needed for each 200,000 of population when the atomic

energy industry approaches full development. Future studies may, of course, alter these values.

It is anticipated that the demand for radiation health specialists will increase progressively as state and local control programs develop. At the present time, the Public Health Service and state and local health agencies have need for 150 specialists who have completed a full program of training in radiation protection. By the end of 1966, it is anticipated that these needs will have expanded to the point where 650 individuals can be profitably utilized; by 1970, it is estimated that 1,200 will be required. These figures are over and above those currently needed by the Atomic Energy Commission for the conduct of its safety programs.

VI. COMMENT AND RECOMMENDATIONS

It is evident from the discussions of preceding sections that radiation hazards constitute an important problem of public health. Furthermore, it is more than likely that this problem will become more difficult in the next few years.

A great deal of progress has been made in recent years toward the development of regulatory programs for the control of radiation hazards. However, even today, a number of serious weaknesses exist within current programs, as previous comments have shown. Among these may be included the absence of uniform regulatory mechanisms covering all radiation sources, an insufficient quantity of scientific data for the development of radiation protection standards, the dual responsibility for promotion and regulation of atomic energy sources currently vested in a single governmental agency, and the shortage of trained personnel with which effective radiation control

progr ms may be carried out. In an effort to correct these weaknesses and, more important, to improve the foundation of the radiation control programs of the United States, the Committee submits the following proposals to the Surgeon General for review and appropriate action. Specifically, the Committee recommends that:

1. Primary responsibility for the nation's protection from radiation hazards be established in a single agency of the Federal Government. The Committee believes that this agency should logically be the U. S. Public Health Service, Department of Health, Education and Welfare, and urges immediate legislation to achieve this objective.

2. The agency be granted authority for broad planning in the field of radiation control. Such planning should include the coordination of state and local regulatory programs with the safety operations of federal and private groups in a manner which will provide a unified attack on problems associated with the control of radiation hazards.

3. This agency be given authority to develop a comprehensive program of control for <u>all</u> sources of radiation. In this connection, the Committee wishes to call attention to the following principles and additional recommendations:

(a) Radiation protection standards constitute a matter of broad national importance: Problems of radiation control frequently do not respect state or regional boundaries but extend across large areas of the nation. Also, the full development of nuclear science

in our society depends in no inconsiderable part on the development of uniform radiation standards which apply in all parts of the country.

Therefore, the Committee recommends that the agency be charged with the responsibility of promulgating uniform, national standards on radiation protection. In order to meet this responsibility, the agency should take full advantage of the guidance provided by the National Committee on Radiation Protection and by other organizations of similar character. Furthermore, the Committee recommends that the agency be granted authority to undertake intensive research programs aimed directly at the provision of scientific data for the development of improved standards of radiation protection.

(b) The enforcement of regulations affecting the health and well-being of our society has traditionally been the responsibility of state and local governmental agencies. There appears to be no fundamental reasons why such agencies should not bear a substantial responsibility for the regulation of the health hazards associated with radiation exposure.

The Committee therefore recommends that as much regulatory responsibility as possible be vested

within state and local governments in the field of radiation protection. However, in order that the agency may be assured of discharging its responsibilities to the nation as a whole, the Committee recommends that the agency be granted supervening authority in those areas of enforcement where federal regulation seems more appropriate. It also recommends that this authority apply under those circumstances where a state or local government finds itself unable to meet its obligations.

Einally, in order that state and local governments may discharge their responsibilities with the greatest effectiveness, the Committee recommends that the agency be granted authority to provide technical and financial assistance to such governments, as in other public health programs.

(c) The training of professional and technical personnel with which to meet federal, state and local requirements over the years, is a problem of national importance. Hence, the Committee recommends that the agency be granted authority to undertake a broad range of training programs which will assure that the national, state and local needs for personnel trained in radiation protection will be satisfactorily met.

VII. PROGRAM BUDGET

It is anticipated that the cost of a comprehensive program of radiation control which includes the elements set forth in the foregoing recommendations will reach a level of approximately 50 million dollars in a period of five years. The Committee recommends, however, that the program be developed gradually, perhaps at a level of approximately $2,500,000 in the fiscal year, 1959-60, and increasing in magnitude until full development is reached in 1965. Even with such progressive staging, the Committee recognizes that the program is a substantial one. However, the criterion of realistic need has been continually before the Committee in its deliberations. There is no question that the present situation calls for bold and decisive action. With such action based upon sound principle, the Committee believes that the Federal Government should proceed with all deliberate speed.

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